

Vial of Life Redesign

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by
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ABSTRACT

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Cambria Anonymous Neighbors (CAN), a nonprofit organization assisting the residences of Cambria, hopes to standardize first responder procedures and make medical information easily accessible in case of a medical emergency. Currently the container costs \$3.78. CAN would like to provide 2000 containers at a lower cost. After researching materials, acrylic was found to be the best option for the container material due to its low cost and durability. A laser cutter was used to cut the acrylic pieces, and then a set of of step by step instructions were created to assemble the product. To reduce the cost of acrylic, the most expensive material in the process, it is recommended for CAN to order at least 51 units of 18" x 24" acrylic. Assuming the labor costs are free because CAN has volunteers, and the laser cutter is free for use, the new container costs \$2.17. This product provides a 43% cost reduction for each container CAN makes and provides for a more flexible options for the medical documents inside of the container.

ACKNOWLEDGMENTS

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I. Introduction

Cambria Anonymous Neighbors (CAN) is a nonprofit organization of 100 volunteers to assist the residences of Cambria and San Simeon. CAN would like to provide a container to be placed on a refrigerator withholding a person's medical information easily accessible to first responders in a medical emergency in the town of Cambria. CAN is looking for a solution to provide a container to every household (~2,000 households). Since the median age of Cambria is around 68 years old, it is important to provide a product that is simple to use. The cost of the current container CAN currently uses is \$3.78 which is no longer a viable option. The purpose of this study is to accomplish the following:

- Design a functional container meeting the expectations and requirements of CAN while maximizing cost reduction
- Provide a set of procedures for material acquisition
- Generate instructions to assemble the container

Ultimately, the statements listed above will standardize first responder procedures for medical emergencies in Cambria, CA.

The project goal will be accomplished by following a sequence of tasks. First, the current state was assessed by identifying existing problems, product requirements and product expectations. Then, product material and associated manufacturability and costs were researched to find a material that would fulfill the product requirements. After choosing the material to be used, a prototype was designed. The prototype will provide insight into project feasibility. Once a design is finalized, procedures for obtaining required materials and building the product will be determined.

The deliverables to be provided after the study include:

- Prototype
- Container design
- Instructions for manufacturing and assembly of container
- Recommendations of where to acquire materials and the quantity to be ordered
- Economic justification of new product design
- Alternative solutions

The proposed solution will be conveyed in the literature review and background, design, methods, and results sections of this report.

II. Background (includes Literature Review)

A literature review was conducted to gain a better understanding of the problem and to understand previously completed work. The literature review is comprised of five different research topics. The first two include information flow in first responder procedures and existing medical identification products. These topics were researched to give more background on the current state, and provide guidance in how the new product should be designed in order to reach the ideal state. The last three research areas include plastic manufacturing processes, the impact of kitting in manufacturing, and the impact of plastic manufacturing on the environment. These topics were researched to understand how the final product should be designed, manufactured, and delivered while being cost effective, operationally efficient, and environmentally sustainable.

First responders are responsible for keeping track of excessive amounts of information in medical emergencies. Making decisions that fail to consider important patient information can lead to consequences that are fatal for the patient. If this information isn't readily available, first responders must rely on others to provide it to them or risk making the wrong decision without it. Unfortunately, information flow in first responder procedures proves to be extremely complicated and ineffective. In case of medical emergencies, even seconds can be a matter of life or death. It's critical to present first responders with the information they need to properly treat patients (Mason 2007).

Recent literature states that many necessary skills of CPR and first aid are forgotten shortly after certification with those who have tried to a high level or have renewed their certification retaining the most knowledge. It has shown that repetition may be more important than days since last trained for skill and knowledge retention, and methods of "refreshing" skills should be examined. While skills deteriorate rapidly, changing frequency of certification is not necessarily the best way to increase retention of skill and knowledge (Anderson). Therefore, It is important for first response personnel to understand appropriate, efficient and equitable emergency planning, response, interaction and communication with children and adults with disabilities before, during and after disasters or emergencies(Wolf-Fordham).

There are several existing products that make important medical information easily accessible. A simple but effective example includes tags with a medical symbol that can be placed on bracelets or necklaces. The tag signals first responders to check the patient's wallet, because the patient has stored a card with medical information inside (Streisfeld 2008). A more direct but similar approach includes a tag that can be worn on shoe laces that has medical information written on the back, which eliminates the first responder having to take the time to look in the patients wallet (Beatty 2002). Additionally, there are bracelets with QR codes that first responders can scan in the case of an emergency. Scanning the QR code allows the first responder to obtain any important medical information, as well as notify any emergency contacts that there has been an

emergency (Forrester 2013). However, since the target market for this product is 65+, it's likely that they won't be as inclined to use a high tech product if they are unfamiliar with how it works (Brickfield 1984).. Unfortunately, the above examples aren't very effective. This is because people find that the products aren't aesthetically pleasing, which makes them hesitant to wear them. To mitigate this, others have tried making alternatives that look like bracelets and that can come as attachments that people can add to jewelry they already have (Gaskill). However, all the above products requires the patient remembering to wear them, especially when leaving the house. For this reason, the design solution is meant to focus on making medical information accessible in the patient's home in the case of a home emergency.

Due to customer requirements, the product will be placed on refrigerators. The first material researched was plastic. Research into plastic manufacturing methods revealed that there are a variety of plastic manufacturing methods, such as blow moulding, compression moulding, injection moulding, rotational moulding, transfer moulding, and thermoforming that each come with their own advantages and disadvantages (Raviwongse 2000). Such methods require custom tooling and therefore longer lead times which are both time and money consuming. Unfortunately, further research into above methods show to be inappropriate for this projects purpose, since only about 2,000 containers are to be manufactured. A laser cutter is ideal for cutting out shapes in a sheet of product designed from any drawing software (Mueller).

Since the goal is to create 2,000 containers, it would be infeasible to deliver completely finished products in the amount of time given. Instead, it's more likely to be able to deliver either pre assembled kits consisting of all the product components with instructions on how the container should be assembled, or just the instructions, depending on time. This is a reasonable deliverable as C.A.N. has volunteers that are willing to assemble the product, and is more organized than just handing off randomly assorted product parts with no direction. This decision led to researching effective kitting methods (Forsman 2002). In manufacturing settings, kitting showed to increase overall productivity and reduced unnecessary transportation and muscle strain (Delen 2005). This is important to do as the volunteers aren't getting paid for this and may want to quit if they become uncomfortable.

Plastic manufacturing has a high impact on carbon footprint, which makes plastic manufacturing processes environmentally unsustainable (Dormer 2013). Plastics could potentially be dangerous due human exposure to toxic components such as bisphenol A (BPA) and di-(2-ethylhexyl)phthalate (DEHP)(North). A company, EcoGlass, which provides environmentally friendly acrylic made from 30 to 50 percent blended, dissimilar, recycled polymers (Top products 2010). Additionally, if a higher volume of products were to be made, a switch to a different and more environmentally sustainable product should be used instead.

Acrylic is a petroleum based product which has superior dimensional stability and an excellent combination of structural and thermal properties (Pauls). It is often used in sheet form due to its properties such as lightweight and shatter resistance, and often serves as an economical alternative to polycarbonate when extreme strength is not desired. Acrylic has many applications including LCD screens and monitors, cavity fillings, signage, and windows(Pawar). Acrylic is known for having crystal clarity and outstanding weatherability (Acrylic).

III. Design

This project includes two design elements- the process to build the container and the design of the container itself. Since 2,000 containers were requested, it's critical to design a cost effective product with operationally efficient processes. The product was designed while considering the following user specifications and design requirements

Design Requirements:

- Medical document storage container
- Straightforward and standardized manufacturing and assembly processes

User Specifications:

- Volume increase from current design to store additional forms
- Lower final product cost
- Attachable to refrigerator
- Include sticker that brings attention to first responders

3.1 Design Requirements

The product will be built by C.A.N. volunteers and should therefore have assembly processes simple to learn. The assembly instructions will consist of processes performed with commonly used tools and materials. The attached magnet must be able to hold the container weight on refrigerators. Finally, the final product shall a larger quantity of documents. Documents include DNR, medical history, allergy information, etc.

3.2 User Specifications

The current container was analyzed to understand what improvements need to be made. The container is roughly 4 inches wide, 11 inches long, and 1/2 inches thick, and comes with 3 forms. Due to the small container size, patients aren't able to place more in the container than the given forms. While the current container provides a place for patients to store medical information, using it requires transferring information from other documents onto the provided forms. The design solution should therefore be large enough to carry standard 8.5" x 11" paper. This eliminates the step of having to copy and transfer information from pre-existing documents to the provided forms. Instead, patients can just simply place the medical documents they have in the container. The new product will come with a sticker to signal for first responders' attention. While the current product cost is \$3.78, the design solution will be cheaper.

3.3 Product Material Selection/Manufacturing

Since methods such as blow moulding, injection moulding, and transfer moulding are time consuming and expensive, manufacturing just 2,000 containers doesn't warrant a

custom plastic manufacturing process. Instead, the new container will be made by assembling pieces cut from an acrylic sheet using a laser cutter. Acrylic was chosen due to its low material cost.

3.4 Modeling Product

The design consists of five acrylic pieces that should be glued together as per provided assembly instructions. The original model was designed on a 11" x 14" Illustrator page, as the first acrylic sheet was sized this way (see Figure 1). This allowed for making two sets of the 5 pieces from just one sheet. Since the laser cutter takes sheets sized up to 18" x 32", future models will be designed on pages of this size instead which will allow for about 4 products per each 18" x 32" sheet. All modeling was performed on Adobe Illustrator.

IV. Methodology

Both design elements of the project (product and process to build the product) were prototyped. The process to build the product was prototyped by creating rough drafts of a Bill of Materials (BOM), Purchase Recommendations, Laser Cutter Instructions, and Assembly Instructions. Additionally, the product was prototyped by building the product from start to finish by following the first drafts of laser cutter instructions and assembly instructions.

3.1 Product Prototype

An 11" x 14" x 1/16" acrylic sheet was purchased to build the first prototype. The acrylic sheet was cut using the laser cutter in the machine shop in Mustang 60. To do this, various PPI, Power, and heat settings had to be determined to get desirable results. Properly choosing these settings was critical, as acrylic is a plastic material and can easily be warped if improper settings are used. Before cutting, the properly cutting height was set up which was determined by the thickness of the sheet that was used. The first set took the laser cutter about 2 minutes and 9 seconds to complete. (Figure 3)

3.2 Process to Build Product Prototype

The four documents illustrating the requirements to build the product were prototyped.

a. Bill of Materials (Figure 4)

The front panel, back panel, side piece, and bottom piece were all cut from the acrylic sheets. The amount of glue varies, it was assumed that each product would consume about 1-5th of a standard hot glue gun stick. Each product also comes with a magnet attached on the back and a sticker to identify that medical information is stored inside of it.

b. Purchase Recommendations

The Economic Order Quantity (EOQ) formula was used to determine purchase recommendations. Quantity discounts and a low holding cost was considered. The ideal acrylic sheet size would have been 18" x 32" to maximize the space inside the laser cutter. After looking at acrylic sheets, the lowest cost per square/inch ended up being the acrylic sheet size at 18" x 24". To the right you can see the quantity of 18" x 24" acrylic sheets ordered with the quantity discount.

Quantity	Cost Per Unit
2 to 5	12.27
6 to 10	9.7
11 to 20	8.77
21 to 30	8.36
31 to 40	8.13
41 to 50	8.05
>=51	7.97

c. Laser Cutter Instructions

After completing the purchase recommendations, laser cutter instructions were generated with the help of the shop technician working at Mustang 60. The Laser Cutter Instructions (Appendix 1) show in detail every step that needs to be taken on the computer and the laser cutter to cut the sheet of acrylic. The height, material, laser settings, and sheet dimension properties need to be carefully calibrated to ensure the acrylic is cut correctly. On average, once everything is set up, it takes the laser cutter about 2 and ½ minutes to cut one container. This translates to around 10 minutes to cut 1 sheet of acrylic for 4 containers.

d. Assembly Instructions

Although the process seems straightforward, and intuitive It was important to clearly explain each of the steps in putting the product together. (Appendix 2) Pictures on what the product should look like throughout each phase were included in this document. Time studies were conducted on the three prototypes built to test the feasibility of building the product with the provided materials and instructions.

V. Results

a. Purchase Recommendations

Quantity	Cost Per Unit
2 to 5	12.27
6 to 10	9.7
11 to 20	8.77
21 to 30	8.36
31 to 40	8.13
41 to 50	8.05
≥ 51	7.97

The EOQ formula showed that C.A.N should purchase 51 orders or more when purchasing acrylic. The way that quantity discounts affected cost per unit is listed in the table on the left. After 51 acrylic sheets the unit cost remains fixed and there is no increased quantity discount. Only acrylic sheets were because that was the biggest cost driver per unit. When ordering 51 sheets of acrylic, C.A.N. should also order 2 packs of glue (with 30 sticks each), 5 sets of magnets (72 pieces per sheet), and 3 glue guns. These are the materials required to create the 204 containers that 51 acrylic sheets allow for.

b. Product Prototype Results

The results of the first product prototype are seen in Figure 5. Unfortunately, all of the pieces got warped because the PPI(pulses per inch) setting was too high. It was also found that all the pieces were about 25% smaller than they were designed to be because



of an error that was made while transferring the part file from Adobe Illustrator to the software interface of the laser cutter. Additionally, the cutting height was set up incorrectly because of an error in entering the sheet thickness. As seen in on the left, this piece actually caught on fire and burned because the heat and PPI settings were too high. After making the necessary changes and adding them into the laser cutter instructions, a final product was successfully built (Figure 9).

VI. Conclusion

In conclusion, the completed deliverables include a newly designed medical information storage container, purchase recommendations, and the required instructions to create it. The product designed allows more flexibility for the documents that are placed inside. Additionally, since C.A.N. no longer has to go out to a third party supplier for the final product, they no longer have to worry about prices suddenly increasing. Although C.A.N. has to make the products themselves, the process was designed so that it's simple enough to be sustainable. Once implemented, placing the product on refrigerators will save time and standardize first responder procedures in the case of medical emergencies in Cambria, CA. Since the recommended product allows for a 41% cost reduction, it is hoped that completing this project helped Cambria Anonymous Neighbors to provide a product at a lower cost to help them reach their goals in serving the Cambria community.

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List of Figures

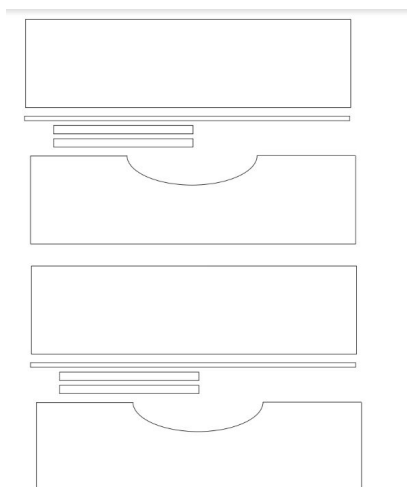


Figure 1: Acrylic Prototype Design

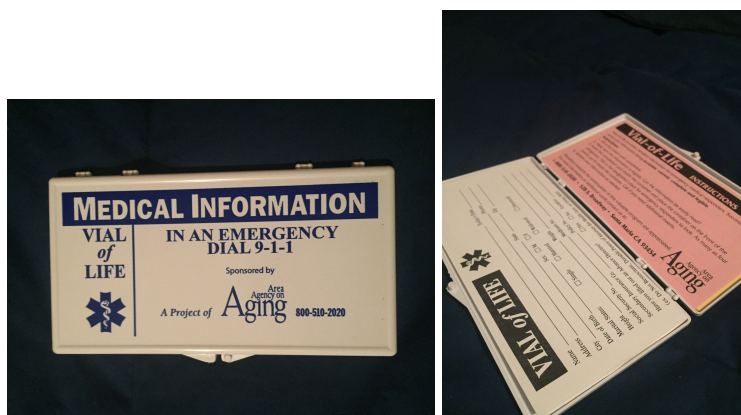


Figure 2: Previous Vial Of Life Container



Figure 3: Laser Cutter

Material	Quantity	Description
Front Panel	1	9" x 4" panel with semicircular opening
Back Panel	1	9" x 4" panel
Side Piece	2	4" x .5" piece
Bottom Piece	1	9" x .5" piece
Glue	As needed	Use enough to hold all pieces together
Magnet	1	
Sticker	1	

Figure 4: BOM



Figure 5: Warped Acrylic from the Laser Cutter

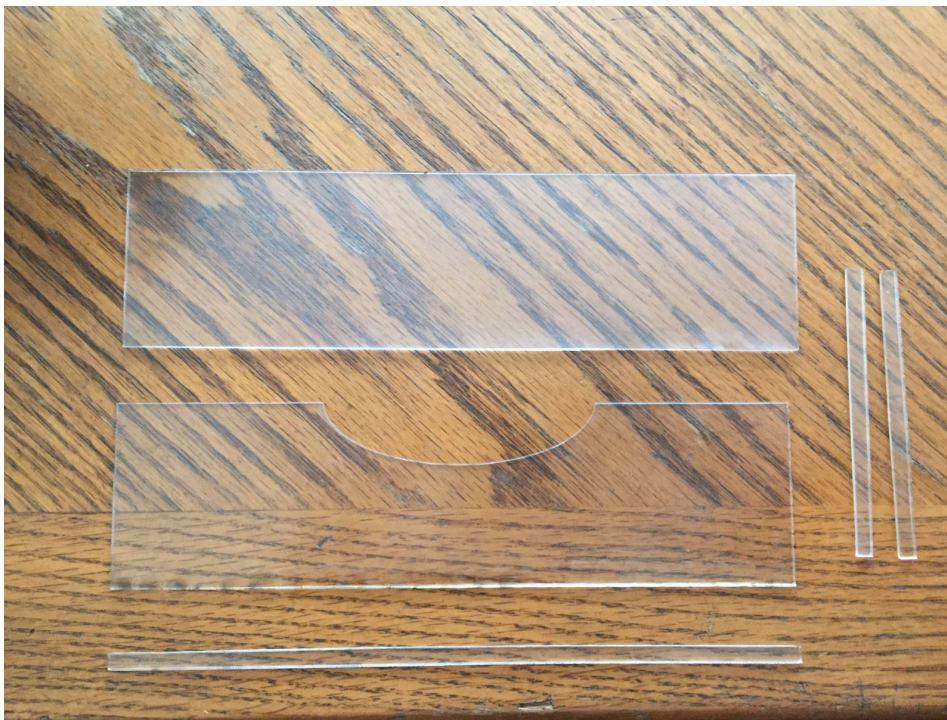


Figure 9: First Prototype Set

Appendix

Appendix 1: Laser cutter instructions

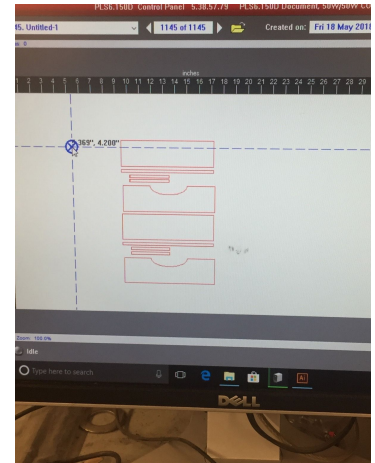
Laser Cutter Instructions

Creating New Laser Cutter File

On computer, click:

File > Laser Bed > **Move part over to laser bed area**

*Make sure to hold shift to make sure dimensions scale correctly



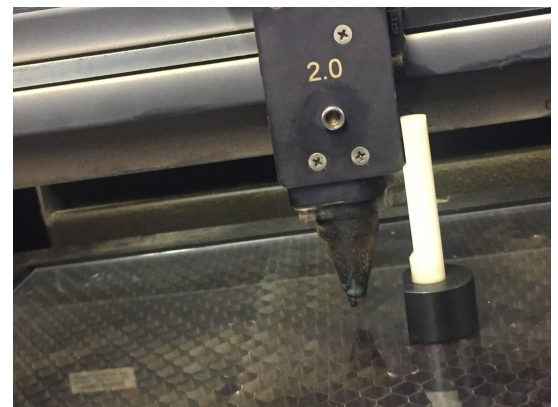
Setting Part Height

On computer, click:

File > Print > Printer > User defined landscape

On laser cutter:

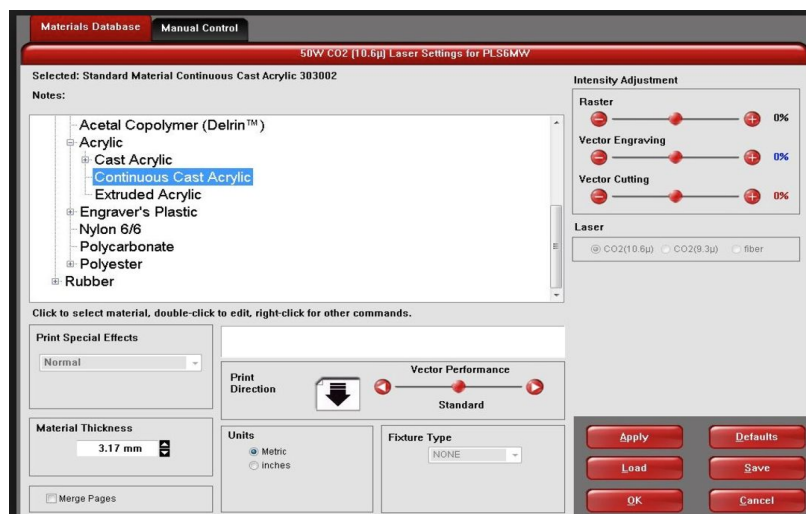
1. Open laser cutter
2. Place part inside
3. Place fixture on part
4. Use the red laser controller on the laser cutter to lower the cutting tool until the tool hits the step on the fixture
5. Use computer to touch four corners of the acrylic sheet to ensure that the sheet is lined up with the cutting tool



Material Settings

On computer, click:

Settings > Material database > Plastics > Acrylic > Extruded acrylic > Set material thickness to .0625" > Set PPI to 500 > Manual control > Mode > Set

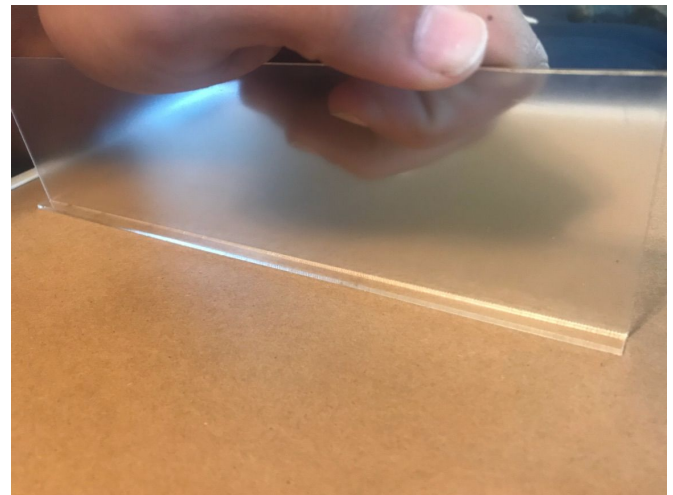


Cutting

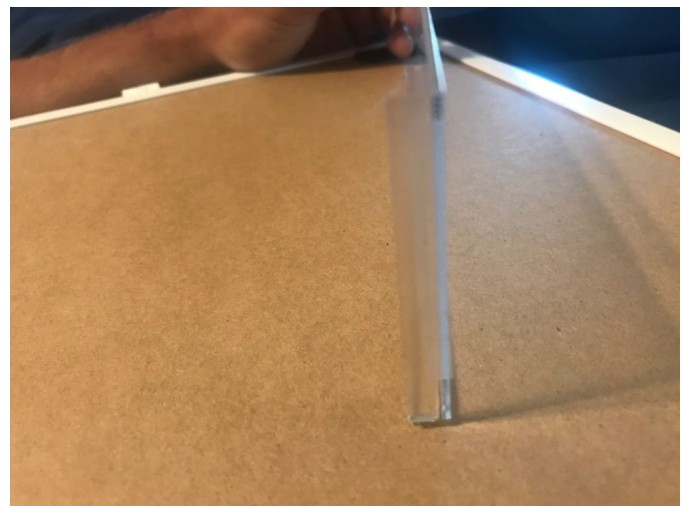
1. Turn on Blow power and air assist
2. On computer: Hit Play and Run
3. Watch laser cutter go to see if acrylic is cut correctly
 - a. If not adjust settings
 - i. PPI
 - ii. Power
 - iii. Z - Height
4. Turn off blow power and air assist

Appendix 2: Assembly Instructions**Assembly Instructions**

1. Attach bottom piece to back piece and use hot glue gun to apply enough glue for



2. Glue each side piece to the sides of the back piece



3. Glue front piece



4. Glue magnet

